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THE EFFECT OF 12-WEEK PLYOMETRIC TRAINING PROGRAM ON ANAEROBIC POWER, SPEED, FLEXIBILITY AND AGILITY FOR ADOLESCENT FOOTBALL PLAYERS

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Abstract:

Purpose: The purpose of this study is to examine the effect of 12-week plyometric training program on anaerobic power, speed, flexibility and agility for adolescent football players.

Methods: 35 football players, 15 of which were in the experimental group and 20 of them were in the control group, participated in the study. Plyometric exercise and technical training have been carried out for the experimental group two days in a week during 12 weeks and only technical training has been implemented for the control group two days in a week. Before and after the exercise program of the experimental subjects, body mass index, anaerobic power, flexibility, 30 m speed, horizontal jump, hexagonal barrier and zig-zag test have been measured. Paired-samples t –test has been used to compare the pretest and posttest values of the experimental subjects and Independent Samples t-test has been used for intergroup comparison.

Results: When pretest and posttest values of the experimental group have been compared at the end of the study, a significant difference has been found in anaerobic power, flexibility, 30 m speed, horizontal jump, hexagonal barrier and zig-zag test values ($p<0,01$, $p<0,05$). In view of the posttest values in intergroup evaluation a significant increase has been found in horizontal jump and anaerobic power ($p<0,01$, $p<0,05$).

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Conclusions: It can be stated according to the findings of the study that the 12-week plyometric training program has a positive effect on speed, flexibility, agility and anaerobic power in view of performance.

Keywords: plyometric, adolescent, football, performance

1. Introduction

Football is one of the most favorite and best loved sport branches in Turkey and in the world (Kutlu & Karadağ, 2003; Marancı & Müniroğlu, 2001). One of the most important reasons for this is the fact that football provides an opportunity for both the players and the spectators to enjoy and take pleasure. Today, there is no other sport that has been popularized except football in Turkey and in the world (Ardıçlı, 2005). That is why football has been used as a social directive by most of the states in the world in accordance with their own wishes and goals (Arı, 2012). Football has been a sport branch which attracts millions of people even in the hardest climate conditions to the stadiums and whose quality increases when it is played fairly and in high technique (Ateş, 2005). This interest in developed countries and our country has made football a part of life by carrying it into schools and clubs (Yamaner, 1990).

Physical active training which is intended to develop motor features is in the foreground in football just like in the other branches. An effective training should be based upon using physical methods appropriate for the individual and also upon physical and physiological needs of the sport branch (Koç, Gökdemir & Kılınç, 2000). The aim of the training program introduced to the players is to improve their physical and physiological efficiency (Gençay & Çoksevim, 2000; Özder & Günay, 1994). The increase in efficiency of the player is the direct result of the quality and the quantity of the practice performed at the training (Müniroğlu, Koz, Atıl, Erongun & Bulca, 2000).

Football is a sport of heavy non-continuous exercises, as well as most of them are aerobic, including actions that require a large number of sprints, negative and positive acceleration, jumps and agility (Shephard, 1999). Actions related with anaerobic energy that occurs heavily in a short time like short range sprints, deflections, abrupt stops, head shots, jump and ball kicks often happen in football (Günay, Yüce & Çolakoğlu, 2001).

Thus, lower extremity power, strength, speed, acceleration and endurance are important performance components for the football player (Hazır, Mahir & Açıkada, 2010).

Football players make moves that require a large number of explosive power like shoot, dribble, jump, steal, sprint and step over during a match (Haghighi, Moghadasi, Nikseresht, Torkfar & Haghighi 2012; Nikseresht 2014).

Elastic power or quick power is the determiner of the performance in sport branches that require deflection like football (Açıkada & Ergen, 1990). Sportsmen use plyometrics in order to improve elastic power, jump activity and leg power (Ateş, 2007). Chu defines plyometrics as exercises and drills which increases power or reactive explosive action and are a mixture of speed and power. The main aim of the plyometrics is to turn elastic energy obtained from body weight and the gravity force during eccentric spasm into counter and equal force during concentric spasm (Chu, 1983).

Some principles like increasing muscular force using resistance which is acceptable in other types of exercises are exactly applicable for plyometric training. In addition, it is possible to increase the endurance of the muscle by multiplying repetition numbers. Resistant exercises in plyometric training can be carried out by moving the extremities abruptly according to the body. Endurance is improved by the increase in repetition numbers (Chu, 1992).

The aim of this study is to examine the effect of 12-week plyometric training program on anaerobic power, speed, flexibility and agility for adolescent football players and to assess the results within the scope of literature.

2. Methods

The current study was carried out at the laboratories and gymnasium of University School of Physical Education and Sport. The Institutional Review Board approved the protocol for this study, and all subjects were informed of the nature of the study and signed a consent form.

2.1. Materials and Technique

The study has been carried out with the participation of 35 randomly selected healthy and volunteer female football players, 15 of which were in the experimental group and 20 of them were in the control group and whose sport experience goes back to at least 2 years. The present study has been executed at Gazi University Football Stadium. Information about the study has been presented to the experimental subjects before the tests. Thus, their motivation levels have been increased to use maximal power. Measurements have been carried out twice; one pretest a week before the training program and one posttest after the training program. Time necessary for warm up and

relaxation has been given to both groups before the tests. Plyometric exercise and technical training have been carried out for the experimental group two days in a week during 12 weeks and only technical training has been implemented for the control group within this period.

Table 1: Physical Value of the Study Group Status

Group		Age	Height (cm)		Body weight (kg)	
			B.E	A.E.	B.E	A.E.
Experiment	n = 15	14,53±0,83	1,63±3,78	1,63±3,80	52,75±6,06	52,42±5,19
Control	n = 20	14,40±1,09	1,58±5,91	1,58±5,93	48,07±7,17	48,99±7,27

2.2. Statistical Analysis

Data obtained at the end of the measurements have been recorded after each measurement instantly. Arithmetic averages of all data, standard deviation (standard errors) have been estimated. Paired-samples t –test has been used to compare the pretest and posttest values of the experimental subjects and Independent Samples t-test has been used for intergroup comparison. It has been looked for whether the results are between 0.05 and 0.01 significance level or not.

2.3. Measurement Methods

Measuring height and body weight: The body weights of the subjects have been scaled on a weighing machine with the sensitivity of 0.01 kg with bare foot, T-shirt and tights. Their heights have been measured using a metal measuring stick with the sensitivity of 0.01 cm with the experimental subjects standing upright position (Tamer, 2000; Yamaner, 1990)

Measuring Body Composition: Measurement of subcutaneous fat of the subjects has been made by using Cilifton N.J brand Skinfold Caliper which measures 0-66mm thickness. Measurements have been taken from 3 areas of the right side of the body of each subject within Skinfold measurement. Measurements have been taken from triceps, suprailiac and femur (Ergun & Baltacı, 2011). 3 places formula (triceps, suprailiac and femur) has been used in body density measurements (Mitchell, Peter, Robert & Lawrence, 2006). Body fat ratio has been determined by using Siri formula (Ergun & Baltacı, 2011).

Measuring Anaerobic Power: Anaerobic power measurements have been carried out by using sargent jump test. In this test, the difference (m) between the height that the individual can reach by standing and the height that the individual can reach by jumping is determined and is read with the body weight from Lewis Nomogram as

kg.m/sec. The test has been repeated 3 times and the best score has been taken (Ergun & Baltacı, 2011).

Flexibility Test (Sit and Reach): A test stand which has a scale for evaluating the measurement on it is needed for practicing the test. The stand is of 35 cm long, 45cm wide and 32 cm height. The top surface size of the stand is as follows: 55cm length, 45 cm width, the top surface is 15 cm outside of the surface that the legs hang. 0-50 cm measurement grid has been determined with 5cm parallel line gaps on top surface. The subject sits on the floor and puts his/her bare foot on the test stand. He/She leans forward (from waist and hip) and tries to reach as far as he/she can without bending knees and with hands in front of the body. He/She should try to stop at the farthest point. The experimental subjects should wait for 1 or 2 seconds at the farthest point without bending towards or backwards in order to have the right measurements. The test maker stands near the experimental subject and prevents the bending of the subject's knees. The test is repeated twice and the highest score is recorded (Günay, Tamer & Cicioğlu, 2006; Mackenıze, 2005).

30 m Speed test: Marking cones are placed with 30 m distance in order to show the starting and finish lines. Experimental subjects ran in their own times by using maximal effort without start command. Subject starts to sprint 1 meter behind the starting line and when he/she passes over the starting line, the assistant there signals by hand signal. Two assistants waiting at starting and the finish lines start the chronometer with this hand signal. When the subject comes to the finish line, the assistant at the finish line signals by hand and both assistants stop the chronometer. The test is repeated twice and the highest score is taken into consideration (Chu, 1996).

Horizontal jump: The experimental subject jumped behind the starting line on the floor as far as he/she could, using maximal force in linear direction by the help of arms while two feet bended at the knees, feet at the shoulder width. The distance between the starting line and the closest trace that he/she left on the line has been recorded in terms of meter. The test is repeated twice and the highest score is taken into consideration (Chu, 1996).

Hexagonal Barrier Test: The space between the hexagonal barriers is 66 cm and the letters A, B, C, D, E and F are given to the lines. The player waits standing in the middle of the hexagon and facing to the line A. When the test starts, the player jumps to the line B and comes back to the middle, jumps to the line C and comes back to the middle again. The player keeps on jumping until he/she comes to the line A. The player completes the first round of the circle when he/she comes to the line A. The player carries on moving until he/she completes the tour of the circle three times. The time is stopped and recorded when the player completes the third tour. The player has a rest

and performs the test again. After he/she performs the second test, the best score of the two tests is recorded (Mackenıze, 2005).

Zig-zag Test: This test is maintained in order to determine the speed and agility of the experimental subject. 4 cones are placed at the corners and 1 cone is placed at the center of the diagram. The long side of the diagram is 16 feet (1 feet=0,3m) and the short side is 10 feet. The player follows a certain route on the diagram. The experimental subject performs the test with maximal power. The test is repeated twice and the highest score is taken into consideration (Mackenıze, 2005).

Package Plyometric Training Introduced to the Research Group: The package training program introduced to the research group has been prepared considering the information given in the literature (Dolu, 1994; Arslan, 2004; Atalay Güzel, Çolakoğlu, Karacan, Öz & Akyüz, 2008). Each sit-up and bench press movement during the training has been accepted as a jump. Each number in the column of exercise type determines the number of the exercises used in the training.

Scope: 5080 jumps have been performed at the end of the 12-week training program with the jump intensity changing between 180 and 240 in a week.

Resting between sets: It has been arranged as 1-2 minutes according to the exercise performed.

Frequency: It has been performed before the training two days in a week. Warm-up and stretching movements have been performed before the exercises.

Exercise number and definition of the actions Introduced to the Research Group:

1. *Skipping a Rope:* The players jump on one foot or on two feet according to the commands with the ropes in their hand (Arslan, 2004).
2. *Jumping on Two Feet Without Using Arms:* The players jump on two feet with the arms lateral on the very spot without pulling legs to the abdomen. (Chu, 1996).
3. *Jumping on Two Feet With Pulling Knees to The Abdomen:* The players jump on the very spot with pulling their knees to the abdomen (Chu, 1996).
4. *Jumping Forward on Two Feet:* The feet are distanced at the shoulder width. The player jumps forward as far as possible with squat. As soon as the feet touch the ground, the player jumps forward again. The player flings his/her arms swiftly. The player should show ultimate attention to keep the feet on the ground for a very short time (Chu, 1996).
5. *Ankle jumping to the sideways:* The cones are placed with the distance of 2 or 3 footsteps as the border. The feet are distanced at the shoulder width. The body is kept in upright position. The player jumps to the sideways on two feet. The aim is to improve the motive power of the ankles. The shoulder width openness of the feet and touching the ground at the same time is very important (Chu, 1996).

6. *Kangaroo Jumping:* The action is performed in predetermined number as defined in the kangaroo jumping position. First one leg is in the front and then the other leg is in the front. The player should show ultimate attention to keep the feet on the ground for a very short time (Chu, 1996).
7. *Horizontal and Vertical Jumping Combination:* A powerful vertical jump is performed after the kangaroo jumping combination. During the last jump, the foot that is not performing jumping action is brought near the foot that is performing the jumping action. Thus, the jumping is performed by two feet. The player flings both arms in order to support rising vertically. The player completes the set of other kangaroo jumping combination as soon as he/she comes down from vertical jump (Bayraktar, 2010).
8. *1-2-3 Drill:* The starting point of the movement and the 20th meter is marked. One foot is slightly in front of the other. The player uses three steps with continuing movements to revive the take-off (left-right-left or right-left-right). Three steps are completed in the rhythm of quick – quicker – the quickest. The player quickly takes off at the end. The take-off movement is emphasized and made well-ordered. After the take-off as soon as the player touches the ground, he/she continues the set for 20 meters without stopping (Chu, 1996).
9. *Hexagon Drill:* A hexagon tape setting which has sides of 60 cm length is arranged. The feet are distanced at the shoulder width and the player stands at the center of the hexagon. He/She jumps to one side of the hexagon and then jumps to the center. In this way, the player jumps to every side and the center of the hexagon. The exercise is performed by completing the tour around the circumference of the hexagon twice (Chu, 1996).
10. *Zig-Zag Drill:* Two parallel lines of 10 meters length and with the distance of 60-100 cm are determined. The player stands in balance on the line. He/She jumps from one line to the other continuously along with 10 meters performing the jump and the landing on the same foot every time. It is not suitable to jump on two feet in landing. The other foot is use to continue the movement set (Chu, 1996).
11. *Jumping forward over the cone:* 3-5 cones are placed in a straight line with the distance of 3 or 6 steps. The feet are distanced at the shoulder width and the player stands at the startup of the cone. The player jumps over each cone with the feet kept at the shoulder width and lands on both feet at the same time. The player flings both arms and tries to decrease the time passed between each cone on the ground (Chu, 1996).

12. *Jumping over the cone and sprinting to different sides with command:* 3-5 cones are placed with 3 or 4 steps far from each other. The feet are distanced at the shoulder width and the player starts facing the first cone. The assistant stands at the end of the cones. The player jumps over the cones with two feet. After he/she jumps over the last cone, he/she sprints nearly 10 meters to the direction that the assistant indicates (Chu, 1996).
13. *Jumping to the side over the cone:* 3-5 cones are placed in a straight line with the distance of 2 or 3 steps. At the beginning of the cone line, the movement starts with the feet at the shoulder width. The player jumps to the side over the cones along the cone line. After the jump is performed over the last cone, the player touches the ground on the outer foot and pushes to change the direction. Then, the player jumps to the opposite direction over the cones with two feet. At the last cone, the player pushes with the outer foot and changes the direction. The movements are performed unceasingly and properly while changing the direction (Chu, 1996).
14. *Barrier Jumping:* Barriers whose distances are determined according to the players are placed on a straight line. Barrier height is arranged between 30 cm and 50 cm again according to the player. It is important in view of safety that the barriers can fall when the player makes mistake. The player stands at the beginning of the barrier line. He/She jumps forward over the barriers with two feet. The movement should come from the hips and knees and the body should be upright. It should be kept in mind that the knees shouldn't move separately or to different sides. The player flings both arms to keep balance and gain height (Chu, 1996).
15. *Jumping to the side over the barrier:* The player stands near the barrier on two legs. He/She jumps vertically to the other side, pulls his/her knees to pass over the barrier and lands to the position in the beginning. This set is kept on until it reaches to the predetermined repetition number (Chu, 1996).
16. *Steadying long jump and barrier jump:* 2-4 barriers are placed in a straight line with the distance of 8 or 12 steps. Barrier height is arranged between 30 cm and 50 cm again according to the player. The player gets ready with the feet distanced at the shoulder width. Starting with two feet, he/she performs steadying long jump. The player stands at the distance of nearly 40 cm in front of the barrier and finalizes the steadying long jump. Then, he/she jumps vertically over the barrier. The movement is accomplished repeating the vertical jump over each barrier following steadying long jump. The player flings both arms in order to maximize both long jump and the vertical jump over the barrier. It has to be taken into

consideration that the time spent on the ground should be the least. Different barrier lengths are used for improvement (Chu, 1996).

17. *One foot barrier and kangaroo jumping:* 3-5 Barriers whose distances are determined according to the players are placed on a straight line. Barrier height is arranged between 30 cm and 50 cm again according to the player. The player stands at the beginning of the barrier line. He/She passes the first barrier with left foot and makes a long kangaroo jump towards the right foot. Other barriers and distances are performed in the same way (Bayraktar, 2010).
18. *Jump Prepared Run and One foot barrier jumping:* One foot is slightly in front of the other. Two steps are used in the run between the barriers (right-left or left-right). Two-steps run are completed in the rhythm of quick – quicker. At the end, the player passes over the barrier with a rapid vertical jump. The take-off movement is emphasized and made well-ordered. As soon as the player steps to the ground, he/she keeps on with the other barriers unceasingly. The player walks to the beginning to have a rest (Bayraktar, 2010).
19. *Box jump:* A box with 15-40 cm height and top surface not being smaller than 60 cm square is selected. The player stands with the feet distanced at the shoulder width facing the box. The player makes a slight squat and jumps onto the box from the ground by flinging both arms (Chu, 1996).
20. *Depth jump:* A box with 30 cm height is selected. The player stands on the box with his/her toes closer to the front side of the box. He/She jumps down from the box and stands on two feet. The player should be ready for the fall beforehand and makes a quick jump to the upwards. The player should prevent the decadence of the body and keep the ground contact at minimum level (Chu, 1996).
21. *Depth jump at predetermined heights:* 2 boxes at equal heights are placed with the distance of 2 or 4 steps. Height and distance can vary according to the player. The player stands facing the second box with the feet distanced at shoulder width, with the tiptoes being closer to the front side of the box. The player jumps down from the box and stands on two feet, jumps onto the second box and comes down slightly. The jump onto the box is performed as quickly as possible (Chu, 1996).
22. *Jumping sideways from the box:* A box with 30-60 cm height according to the player is selected. The feet stands on the side of the box distanced at shoulder width. A jump is made onto the box and the player comes down to the other side of the box. This exercise can be performed with one box or a line of 3-5 boxes with equal heights as continuing actions (Chu, 1996).

23. *Serial jump from the box:* Serial jump over the boxes placed at certain intervals is performed (Chu, 1996).
24. *Depth jump and sprinting to different sides with command:* A box with 30-100 cm height according to the player is selected. The player stands facing the assistant, on the box with the tiptoes being closer to the side of the box. The player jumps down from the box and stands on two feet. Then, the assistant indicates to the right or the left and a 10-12 meters sprint is performed towards that direction (Chu, 1996).
25. *Depth jump and receiving a pass:* A box with 30-60 cm height according to the player and a ball (medicine ball, soccer ball, volleyball, handball and basketball) are selected. The player stands facing the assistant, on the box with the tiptoes being closer to the side of the box. The player jumps down from the box and stands on two feet. An explosive jump is made upwards and at the top point of the jump, the arms are stretched to receive a pass from the assistant (Chu, 1996).
26. *Depth jump and barrier jump:* A box with 30-50 cm height and a barrier with 30-50 cm height according to the player are selected. The barrier is placed nearly 3 steps away from the box. The player stands on the box with the feet distanced at shoulder width. The player jumps down and jumps over the barrier (Chu, 1996).
27. *Box – Barrier – Box jump and Box Jump:* Two boxes with 30-70 cm height and equal height and a barrier with 30-50 cm height according to the player are selected. Each box is placed 2-3 steps from away from the barrier (one to the front, one to the back). The player stands on the box with the feet distanced at shoulder width. The player jumps down and jumps over the barrier. As soon as the barrier is passed, another jump is performed onto the box in the direction of the movement. The action is completed with an explosive vertical jump on the box. The player walks to the beginning to have a rest (Bayraktar, 2010).
28. *Throw-in:* Throw-in (Chu, 1996).
29. *Serial jumps from the boxes at different heights:*

    a) 5 boxes of 40 cm each and 5 boxes of 50 cm each are arranged in mixed order and the players jump over them serially.

    b) 5 boxes of 40 cm each are arranged one after the other. Then 5 boxes of 50 cm each are arranged one after the other. Then, the players serially jump one after the other (Cicioğlu, 1995).
30. *Sit-up with medicine ball:* The player lies on his/her back and keeps his/her knees at flexion position. He/She holds the 2 kg-medicine ball over his/her head and his/her partner stands in front of his/her feet. He/She throws the medicine ball to

his/her partner while doing the sit-up movement. His/Her partner throws the ball again while he/she is lying (Chu, 1996).

31. *Bench Press with Medicine Ball:* The player lies on his/her back with his/her arms stretched upwards and his/her partner stands on the box with the medicine ball in his/her hand. He/She lets the ball out of his/her hands downwards, other partner catches the ball and throws it back upwards (Chu, 1996).

Table 2: Pliometric Training Program Status Applied to the Research Group

No	Exercise Type	1. Week	2. Week	3. Week	4. Week	5. Week	6. Week	7. Week	8. Week	9. Week	10. Week	11. Week	12. Week
1	Skipping a rope	2x20	2x20	2x20	2x20	2x20	2x20	2x20	2x20	2x20	2x20	2x20	2x20
2	Jumping on two feet without using arms	2x10	2x10										
3	Jumping on two feet with pulling knees to the abdomen	2x10	2x10	2x15									
4	Jumping forward on two feet	2x10	2x10										
5	Ankle jumping to the sideways		2x10	2x10				2x10				2x15	
6	Kangaroo Jumping	2x10		2x10					2x10		2x10		
7	Horizontal and Vertical Jumping Combination					2x10					2x10		2x10
8	1-2-3 Drill			2x10						2x10			
9	Hexagon Drill					2x10					2x10		
10	Zig-Zag Drill						2x10						2x10
11	Jumping forward over the cone			2x10						2x15			
12	Jumping over the cone and sprinting to different sides with command					2x10							
13	Jumping to the side over the cone				2x15				2x15				
14	Barrier Jumping	2x10	2x10										
15	Jumping to the side over the			2x10									

	barrier												
16	Steadying long jump and barrier jump	2x10	2x10	2x10								2x10	
17	One foot barrier and kangaroo jumping						2x10						
18	Jump Prepared Run and One foot barrier jumping							2x10					
19	Box jump	2x10	2x10				2x15		2x15		2x15		
20	Depth jump				2x15			2x15					
21	Depth jump at predetermined heights				2x10			2x10					2x10
22	Jumping sideways from the box				2x10				2x10				
23	Serial jump from the box					2x10						2x10	
24	Depth jump and sprinting to different sides with command						2x10			2x10	2x15	2x10	
25	Depth jump and receiving a pass					2x15		2x10	2x10	2x15			
26	Depth jump and barrier jump	2x10	2x10		2x10		2x10			2x10			2x10
27	Box – Barrier – Box jump and Box Jump						2x10						2x10
28	Throw-in			2x10	2x10		2x10					2x10	2x10
29a	Serial jumps from the boxes at different heights (a)								2x10			2x10	
29b	Serial jumps from the boxes at different heights (b)										2x10		
30	Sit-up with medicine ball				2x10	2x15		2x15	2x15	2x15	2x10	2x15	2x20
31	Bench Press with Medicine Ball				2x10	2x15	2x10			2x10	2x10	2x15	2x20

Table 3: Control and Research Group's Measurement Results and Evaluation Status

Variables	Measurement	Control Group n=20 average	% value	t	Experiment Group n=15	% value	t	Control ve Experiment Group Comparison t Value
Anaerobic Power (kg.m/sn)	Before Exercise	27.25 ±6.67	-8.29	-4.107**	30.24 ±6.26	-14.51	-2.584**	1.347
	After Exercise	29.51 ±6.63			34.63 ±5.76			2.391*
Horizontal Splash (m)	Before Exercise	1.59 ±0.13	0	-1.142	1.60 ±0.11	-11.25	-7.348**	.342
	After Exercise	1.59 ±0.13			1.78 ±0.13			4.189**
30m Speed (sn)	Before Exercise	5.28 ±0.40	0.18	1.187	5.39 ±0.30	4.82	6.171**	.845
	After Exercise	5.27 ±0.39			5.13 ±0.26			-1.214
Flexibility (cm)	Before Exercise	22.95 ±5.59	-4.09	-5.846**	23.80 ±9.30	-15.84	-5.096**	.338
	After Exercise	23.89 ±5.61			27.57 ±8.11			1.589
Hexagon Obstacle (sn)	Before Exercise	12.83 ±1.32	4.91	4.157**	12.90 ±1.36	8.21	7.110**	.160
	After Exercise	12.20 ±0.94			11.84 ±0.96			-1.139
Zig-zag (sn)	Before Exercise	7.25 ±0.77	-0.82	-.335	7.55 ±0.74	7.41	6.158**	1.172
	After Exercise	7.31 ±0.61			6.99 ±0.56			-1.596

*p<0.05 **p<0.01

According to the table after the program, no significant difference has been found for the control group in view of the values of horizontal jump, 30m speed and zig-zag (p>0.05) while a significant increase has been found for the values of anaerobic power and flexibility, a significant decrease has been found for the values of hexagon (p<0.01). In the comparison made before and after the training for the research group, a significant increase has been found in view of the values of anaerobic power, horizontal jump and flexibility; a significant decrease has been found in view of the values of 30m speed, hexagon and zig-zag (p<0.01).

3. Discussion and Conclusion

Today, plyometric training has become a training technique which is used by the players within every kind of sports in order to increase general force and explosive force. Plyometric includes quick tension of a muscle (eccentric move) and then a concentric tension of the same muscle or the soft issue and is used to produce more power (Miller, Herniman, Ricard, Cheatham & Michael, 2006).

Quick accelerations, changing directions, abrupt stops, rising to a headshot and shooting in football are the movements related with anaerobic energy requiring explosive power (Akgün, 1989). Quadriceps, gastrocnemius, hamstring muscles are used as explosive power for jumping, kicking and turning. For this reason, it should be improved (Ateş, 2007).

In the study, considering the values of anaerobic power pretest and posttest, respectively it has been found as 30.24±6.26 kg.m/sec – 34.63±5.76 kg.m/sec for the research group; as 27.25±6.67 kg.m/sec – 29.51±6.63 kg.m/sec for the control group. A significant increase in the values of anaerobic power has been found in the comparison made before and after the training for the experimental group ($p<0.01$). After the program, a significant increase has been found in view of the values of anaerobic power of the control group ($p<0.01$). In the intergroup comparison, no significant difference has been found for the values of anaerobic power before the training ($p>0.05$). The value of anaerobic power of the experimental group after training has been found significantly higher than the value of the control group ($p<0.05$). In another study, the effect of 10-week plyometric training on jumping performance of 12-14 year-old football players has been examined. The values of the experimental group before and after the training have been found as 48.16 ± 6.89 kg.m/sec – 52.05 ± 9.69 kg.m/sec and a significant difference has been found ($p<0.05$) (Çavdar, 2006). It has been stated in the literature that plyometric training improves anaerobic power feature. The results of our research have parallels with this information. However, the values of the players within our research group have been found as lower.

In the study, considering the values of horizontal jumping, the average values of horizontal jumping in view of pretest and posttest, respectively, have been found as 1.60±0.11 m – 1.78±0.13 m for the research group and as 1.59±0.13 m – 1.59±0.13 mfor the control group. A significant increase in the values of horizontal jumping after training has been found for the experimental group ($p<0.01$). After the program, no significant difference has been found statistically in view of the values of horizontal jumping of the control group ($p>0.05$). In the intergroup comparison, it has been found that the values of horizontal jumping after training for the experimental group are significantly higher

than the ones for the control group ($p<0.01$). In our study, a significant increase has been found in the values of horizontal jumping and training effect. It can be assumed that these findings which are parallel with the literature are the indicators of positive effect of the regular training.

It can be said that the football players whose sprint time is good have important and effective role in a football match. The speed of a football player is advantageous for the football player within the positions of stopping the opponent, stealing and keeping the ball and scoring a goal. Also, it can be stated that many actions affecting the result in football arise during or after a high speed sprint. It can be said that time advantage for 0.03 seconds during the action of a football player who has a better sprint time is very important in view of reaching the ball earlier (Eniseler, Çamlıyer & Göde, 1996).

Plyometric training is a perfect method improves both strength and power in muscles requiring sprint. Most athletes cannot reach the necessary power for speed although they are strong. It has been observed that plyometric training improves the sprint speed when it is carried out with other training program. Explosive power can be improved by training. The previous researches have showed that the speed improves by increasing the strength of the muscles (Arslan, 2004).

Although there have been increases in the values of 30m sprint speed of the groups, the increase in the research group has been observed as %4.82 and the improvement in the control group has been observed as %0.18. A significant decrease in the values of 30m speed has been found in the comparison made before and after the training for the experimental group ($p<0.01$). No significant difference has been found for the values of 30m speed after training for the control group ($p>0.05$). It can be said that this increase in the experimental group results from plyometric training carried out along with the normal football training program. It has been stated in the literature that plyometric training improves speed feature. The results of our research have parallels with this information.

Flexibility depends on several factors such as joint structure, muscle body, flexibility of the capsule and collagen tissues, greatness and evenness of jointing of the boned structures, intramuscular and intermuscular coordination, age, psychology, environmental conditions, level of training, fatigue and warm-up (Baltacı, Tunay, Tuncer & Ergun, 2003). Plyometric training improves the relationship between maximum power and explosive force. Strength and power training in high level causes the improvement in muscular and intermuscular coordination and correspondingly increase in strength and hypertrophy (Guyton, 1996). In the study, the average values of flexibility in view of pretest and posttest have been found as 23.80±9.30 cm – 27.57±8.11 cm for the research group and as 22.95±5.59 cm – 23.89±5.61cm for the control group. A

significant increase in the values of flexibility has been found in the comparison made before and after the training for the experimental group ($p<0.01$). After the program, a significant increase has been found in view of the values of flexibility of the control group ($p<0.01$). It can be said when compared with the literature that stretching movements for 10 or 15 minutes performed before plyometric exercise improves flexibility (Arslan, 2004).

Agility is an important feature of a football player that affects his/her performance during both the training and the match. Frequently using the actions such as sudden decisions, quickness, and reflex that the game requires presents the necessity of the improved agility feature for the football player (Besler, 2010).

In the study, the average values of hexagon in view of pretest and posttest have been found as 12.90±1.36 sec – 11.84±0.96 sec for the research group and as 12.83±1.32 sec. – 12.20±0.94 sec. for the control group. A significant decrease in the values of hexagon has been found in the comparison made before and after the training for the experimental group ($p<0.01$). In a study, the comparison of physical, physiological and anthropometric features of 13-16 year-old female volleyball and football players has been examined. At the end of the study, the values of hexagon barrier test have been found positive for the benefit of the players ($p<0.05$) (Atalay Guzel, Çolakoğlu, Karacan, Öz & Akyüz, 2007). In another study, the comparison of physical, physiological and anthropometric features of adolescent female volleyball players whose average age is 15.18±0.98 years and the football players whose average age is 14.91±1.04 years has been examined. They have searched the differences between branches and have found that the values of hexagon barrier test are positive for the benefit of the football players ($p<0.05$) (Atalay Guzel, Çolakoğlu, Karacan, Öz, Akyüz & Arslanoğlu, 2008). In our study, a significant decrease has been found in the values of hexagon and training effect. It can be assumed that these findings which are parallel with the literature are the indicators of positive effect of the regular training.

In the study, the average values of zig-zag in view of pretest and posttest have been found as 7.55±0.74 sec – 6.99±0.56 sec for the research group and as 7.25±0.77 sec – 7.31±0.61 sec. for the control group. A significant decrease in the values of zig-zag has been found in the comparison made before and after the training for the experimental group ($p<0.01$). After the program, no significant difference has been found in view of the values of zig-zag of the control group ($p>0.05$). In a study, the comparison of physical, physiological and anthropometric features of adolescent female volleyball players whose average age is 15.18±0.98 yıl years and the football players whose average age is 14.91±1.04 years has been examined. They have searched the differences between branches and have found that the values of zig-zag test are positive for the

benefit of the football players ($p<0.05$) (Atalay Guzel, Çolakoğlu, Karacan, Öz, Akyüz & Arslanoğlu, 2008). In another study, the comparison of physical, physiological and anthropometric features of 13-16 year-old female volleyball and football players has been examined. At the end of the study, the values of zig-zag test have been found positive for the benefit of the players ($p<0.05$) (Atalay Guzel, Çolakoğlu, Karacan, Öz & Akyüz, 2007). According to the findings, it can be said plyometric training causes positive improvements in the values of agility feature.

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